

# Ichthyofauna of the ribeirão Sucuri, a tributary of the rio Tietê, upper rio Paraná basin, southeastern Brazil

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## Abstract

The ribeirão Sucuri, a tributary of the rio Tietê, and part of the upper rio Paraná basin, is located in the municipality of Pongaí, São Paulo state. The ichthyofauna of ribeirão Sucuri was sampled at nine collection sites in May 2018. Our study captured 408 specimens representing five orders, 11 families, and 35 species. Among the species collected, two have not been previously reported from the rio Tietê basin: *Eigenmannia guiraca* Peixoto, Dutra & Wosiacki, 2015 and *Hoplias misionera* Rosso, Mabragaña, González-Castro, Delpiani, Avigliano, Schenone & Dias de Astarloa, 2016. Additionally, four species were found that are non-native: *Hoplias misionera*, *Poecilia reticulata* Peters, 1859, *Roeboides descalvadensis* Fowler, 1932, and *Satanoperca* sp. This study represents the first fish inventory of a tributary on the left margin of the Tietê-Batalha sub-basin and only the second for this portion of the rio Tietê. Our results increase to 55 the number of species recorded from this sub-basin and add data on the putative morphological variation in several species.

## Keywords

Diversity, inventory, Neotropical freshwater fishes, Tietê-Batalha sub-basin.

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## Introduction

The Neotropical region harbors one of the highest ichthyological diversities on the globe (Albert et al. 2011). About 9,100 valid species are currently known from South America, among which 5,160 species are restricted to freshwater environments, which represent roughly one-third of all known freshwater fishes of the world (Reis et al. 2016).

The La Plata, formed by Paraná, Paraguay, and Uruguay river basins, houses the third most diverse

ichthyofauna in South America, after the Amazon and Orinoco rivers, with more than 920 species (Reis et al. 2016) based on innumerable inventories and catalogs of fishes in its sub-basins and tributaries.

The ichthyofauna of the rio Paraná is best studied and understood in its upper portion, with approximately 310 species (Castro et al. 2003, 2004, 2005; Graça and Pavanelli 2007; Langeani et al. 2007; Fagundes et al. 2015; Cetra et al. 2016; Batista-Silva et al. 2018; Ota et al.

2018; Diniz et al. 2019; Jarduli et al. 2020), even though many regions still remain uninvestigated (Fagundes et al. 2015).

The rio Tietê is one of the largest tributaries of the upper Paraná and may be divided into six sub-basins: upper Tietê, Tietê-Jacaré, Piracicaba-Capivari-Jundiaí, Sorocaba-middle Tietê, Tietê-Batalha, and lower Tietê (Ribeiro 2004). Several papers documented the fish diversity throughout this river (Uieda and Barreto 1999; Barrella and Petrere Jr 2003; Giamas et al. 2004; Castro et al. 2005; Langeani et al. 2005; Silva et al. 2006; Vidotto and Carvalho 2007; Esguícero and Arcifa 2011; Marцениuk et al. 2011; Pazian et al. 2011; Smith et al. 2014; 2018; Serra et al. 2015; Yoshida et al. 2016).

Even with all these efforts, some portions of the rio Tietê still remain mostly unsampled, as is the case of the Tietê-Batalha sub-basin (see Smith et al. 2018). This sub-basin is located between the Ibitinga and Promissão dams, in São Paulo state. The landscape in this sub-basin has intensive agricultural activities, which have caused erosion and left only 5% of the native vegetation intact (Ribeiro 2004). Serra et al. (2015), who presented the only ichththyofaunistic study for this area, listed 41 species in the ribeirão Borá, a small tributary of the rio Cubatão. Considering the environmental threats and the deficit of standardized fish inventories for the area, the main objective of our study was to inventory the ichthyofauna of the ribeirão Sucuri, a tributary of the Tietê-Batalha sub-basin, and contribute to the knowledge of the fish diversity of the upper rio Paraná.

Methods

**Study area.** The ribeirão Sucuri is located at Pongai municipality, in the midwestern part of São Paulo state. The region was originally characterized by Mata Atlântica (semi-deciduous seasonal forest) and Cerrado biomes. The ribeirão Sucuri is a direct tributary of the left margin of the rio Tietê, which opens just upstream Promissão Reservoir. It is formed by 17 tributaries, which are sourced by more than 140 springs (Brumati and Souza 2017). The approximate values of total length and area of all watercourses are 173.7 km and 170 km<sup>2</sup> respectively, which were calculated in the Google Earth 7.3 using the polygon and path tools. Nine sampling sites were established, which include both rural and urban

areas with varying influence of the Promissão Reservoir (Table 1; Figs 1, 2).

**Fish sampling.** The specimens were collected in May 2018, under permit by IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis)/SISBIO (license no. 46904-1), using a net of 1.2 m<sup>2</sup>, carried out by two researchers. The specimens were euthanized following the protocol of Fernandes et al. (2017) and then fixed in 96% alcohol. One specimen of each species was photographed in the field and all coloration descriptions were based on these photographs. The specimens were deposited in the fish collection of the Laboratório de Biologia e Genética de Peixes (LBP), Instituto de Biociências da UNESP de Botucatu, Universidade Estadual Paulista, Botucatu, São Paulo, Brazil.

The species were identified by consulting the literature revisionary work (Lucinda 2008; Peixoto et al. 2015; Rosso et al. 2016; Craig et al. 2018; Roxo et al. 2016), inventories (Castro et al. 2005; Langeani et al. 2007), and identification keys (Castro et al. 2003, 2004; Ota et al. 2018). The taxonomic order and classification follow Fricke et al. (2020). Descriptions were based on 10 specimens of each species, whenever possible; for species with fewer than 10 specimens, all were analyzed.

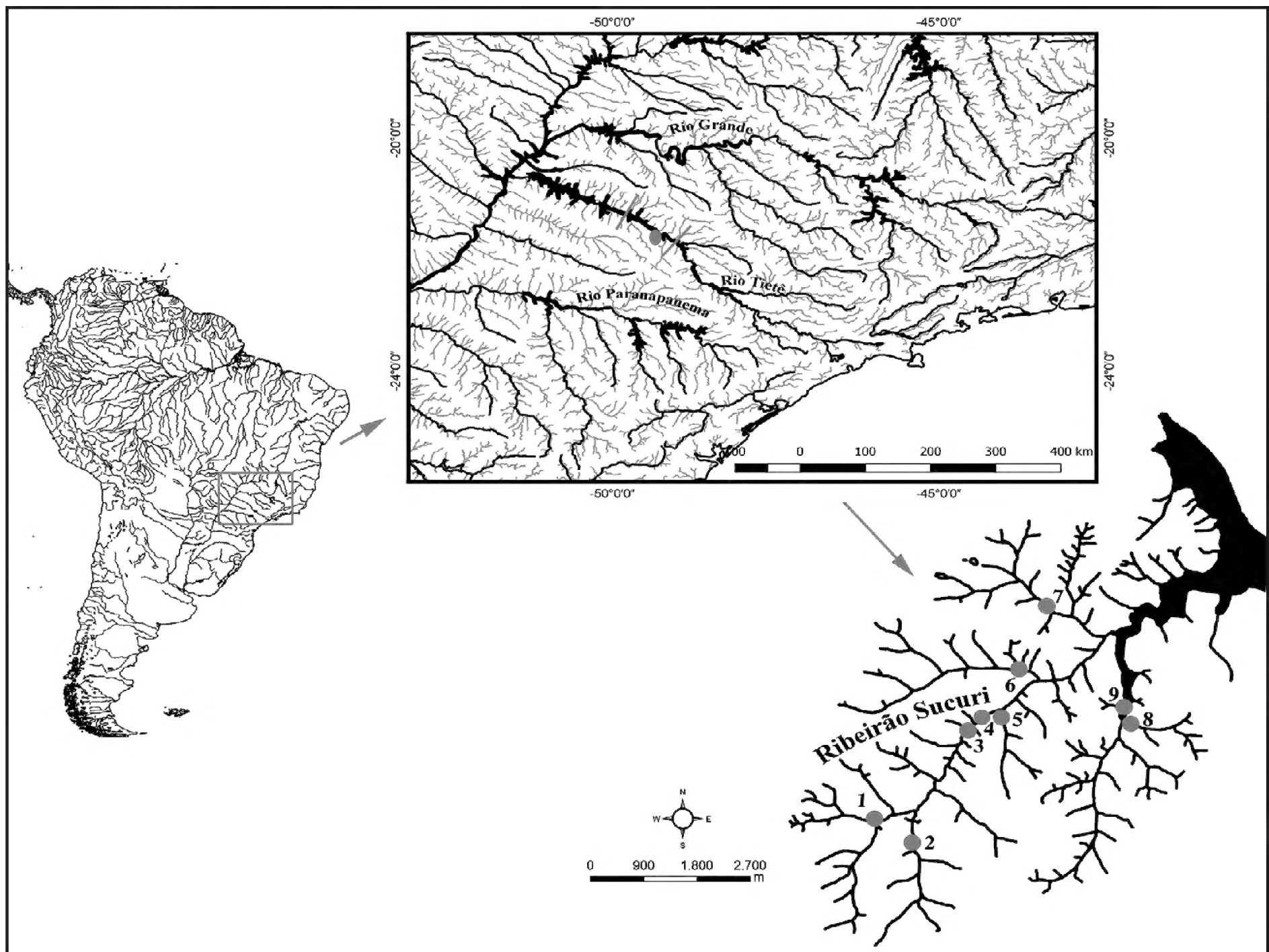
Results

We recorded 35 species (*n* = 408 specimens) from ribeirão Sucuri, belonging to five orders, 11 families, and 29 genera (Table 2; Fig. 3). From the collected species, 42.9% are represented by Characiformes, followed by 31.4% Siluriformes, 11.4% Cichliformes, 8.6% Gymnotiformes, and 5.7% Cyprinodontiformes (Fig. 4). Characidae was the most representative family (Fig. 5), with 12 species. The most abundant species were *Piabina argentea* Reinhardt, 1867 (15.2%), *Hisonotus francirochai* (Ihering, 1928) (13.0%), and *Phalloceros harpagos* Lucinda, 2008, (10.3%) (Fig. 6). Four non-native species were collected: *Hoplias misionera* Rosso, Mabragaña, González-Castro, Delpiani, Avigliano, Schenone & Días de Astarloa, 2016; *Poecilia reticulata* Peters, 1859; *Roeboides descalvadensis* Fowler, 1932; and *Satanoperca* sp.

Order Characiformes  
Family Crenuchidae

**Table 1.** Information about collection sites in ribeirão Sucuri, rio Tietê-Batalha sub-basin, upper rio Paraná basin.

Site	Stream	Latitude (S)	Longitude (W)	Riparian vegetation	Main impacts
1	Córrego Santa Rosa	21°46'29"	049°23'34"	marginal veg., shrubs and grasses	Pasture
2	Córrego Zanata	21°47'02"	049°22'44"	marginal veg., shrubs and grasses, and scattered trees	Pasture
3	Ribeirão Sucuri	21°44'19"	049°21'56"	marginal veg., higher concentration of grasses, and scattered trees	Pasture
4	Córrego da Mina	21°43'45"	049°21'29"	marginal veg., higher concentration of grasses and areas with clay	Pasture and urban area
5	Córrego Saltinho	21°44'02"	049°21'18"	marginal veg., higher concentration of grasses and shrubs	Pasture and urban area
6	Córrego da Aldeia	21°42'57"	049°21'26"	marginal veg., pasture grasses, sand bank, and scattered trees	Pasture
7	Córrego Água Grande	21°41'31"	049°20'31"	marginal veg., higher concentration of grasses	Pasture
8	Córrego da Pata	21°43'49"	049°18'38"	marginal veg., pasture grasses, sand bank, and scattered trees	Pasture
9	Ribeirão Sucurizinho	21°43'39"	049°18'54"	marginal veg., higher concentration of grasses, and scattered trees	Pasture



**Figure 1.** Map of the study area indicating the sampling sites in the ribeirão Sucuri, rio Tietê basin, upper rio Paraná basin, Brazil. The blue bars are the limits of Tietê-Batalha sub-basin.

#### Subfamily Characidiinae

##### *Characidium* aff. *zebra* Eigenmann, 1909

Figure 3B

**Original description.** *Characidium zebra* Eigenmann 1909: 38.

**Material examined.** BRAZIL • 2, 57.0–57.8 mm SL; São Paulo state, Pongai, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26477) • 4, 53.5–62.5 mm SL; São Paulo state, Pongai, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26501).

**Identification.** Body elongated; mouth terminal; premaxilla with six to eight tricuspidate teeth in a single row; dentary with seven to eight tricuspidate teeth; maxilla toothless. Lateral line complete with 37 to 38 perforated scales; four horizontal scale rows above lateral line; three horizontal scale rows below lateral line. Overall body coloration golden; 10 conspicuous dark bars; smaller rounded conspicuous dark humeral blotch; conspicuous midlateral dark stripe extending from anterior margin of humeral blotch to caudal peduncle; dark stripe extending from snout to posterior margin of opercle; hyaline fins.

#### Family Lebiasinidae

##### Subfamily Pyrrhulininae

##### *Pyrrhulina australis* Eigenmann & Kennedy, 1903

Figure 3G

**Original description.** *Pyrrhulina australis* Eigenmann and Kennedy 1903: 508.

**Material examined.** BRAZIL • 2, 22.0–23.9 mm SL; São Paulo state, Pongai, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26530) • 4, 23.4–27.5 mm SL; São Paulo state, Pongai, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26621).

**Identification.** Body elongated; mouth superior; all teeth conical, premaxillary teeth in two rows, inner row with 13 to 16 teeth, outer row with 10 to 12 teeth; three to five teeth on maxilla; dentary teeth in two rows, inner row with 17 to 19 teeth, outer row with eight to 11 teeth. Lateral line unpored; longitudinal series with 20 to 23 scales; six transversal scale rows. Overall body coloration golden to orange; conspicuous dark blotch on dorsal fin; a conspicuous horizontal dark blotch from inferior lip to posterior margin of opercle; fins orange.



**Figure 2.** Photos showing the sampling sites in the ribeirão Sucuri, rio Tietê, upper rio Paraná basin, Brazil.

Family Erythrinidae

***Hoplias misionera* Rosso, Mabragaña, González-Castro, Delpiani, Avigliano, Schenone & Días de Astarloa, 2016**

Figure 3A

**Original description.** *Hoplias misionera* Rosso et al. 2016: 200.

**Material examined.** BRAZIL • 1, 120.2 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26478) • 1, 34.6 mm SL; São Paulo state, Pongaí, Córrego Saltinho; 21°44'02"S, 049°21'18"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26515) • 2, 61.7–73.2 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26524).

**Identification.** Body elongated; mouth terminal; all teeth conical, premaxilla with eight to 10 teeth in a single row; 31 to 38 teeth on maxilla; dentary teeth in two rows, inner row with 11 or 12 and outer row with 14 to 16 conic teeth. Lateral line complete with 38 or 39 perforated scales; five horizontal scale rows above lateral line; four or five horizontal scale rows below lateral line. Overall body coloration yellowish; six to nine conspicuous dark bars; conspicuous midlateral dark band from posterior margin of opercle to caudal peduncle; dark blotch on opercular area and dark stripe on infraorbital; yellowish fins with dark stripes.

**Remarks.** In descriptions of *H. misionera* by Rosso et al. (2016), the number of perforated scales on the lateral line was said to vary from 40 to 43. Ota et al. (2018) observed 39–43 scales, and we observed 38–39, further increasing the variation.

**Table 2.** List of species found in ribeirão Sucuri, middle rio Tietê, upper rio Paraná basin. \*= non-natives species for the upper rio Paraná basin, \*\*= species not shared with study of Serra et al. 2015.

Order	Family	Subfamily	Species
Characiformes	Crenuchidae	Characidiinae	<i>Characidium</i> aff. <i>zebra</i> Eigenmann, 1909
	Lebiasinidae	Pyrrhulinae	<i>Pyrrhulina australis</i> ** Eigenmann & Kennedy, 1903
	Erythrinidae		<i>Hoplias missioneira</i> * Rosso, Mabragaña, González-Castro, Delpiani, Avigliano, Schenone & Días de Astarloa, 2016
	Characidae	Stethaprioninae	<i>Astyanax lacustris</i> (Lütken, 1875)
			<i>Psalidodon anisitsi</i> ** (Eigenmann, 1907)
			<i>Psalidodon</i> aff. <i>fasciatus</i> (Cuvier, 1819)
			<i>Psalidodon paranae</i> ** (Eigenmann, 1914)
			<i>Hyphessobrycon eques</i> (Steindachner, 1882)
			<i>Moenkhausia bonita</i> Benine, Castro & Sabino 2004
			<i>Moenkhausia</i> cf. <i>sanctaefilomenae</i> (Steindachner, 1907)
			<i>Oligosarcus pinto</i> Amaral Campos, 1945
			<i>Piabarchus stramineus</i> (Eigenmann, 1908)
			<i>Piabina argentea</i> Reinhardt, 1867
		Cheirodontinae	<i>Serrapinnus notomelas</i> (Eigenmann, 1915)
		Characinae	<i>Roeboides descalvadensis</i> * ** Fowler, 1932
Gymnotiformes	Gymnotidae		<i>Gymnotus</i> cf. <i>cui</i> a** Craig, Malabarba, Crampton & Albert, 2018
	Sternopygidae		<i>Eigenmannia guairaca</i> ** Peixoto, Dutra & Wosiacki, 2015
			<i>Sternopygus macrurus</i> ** (Bloch & Schneider, 1801)
Siluriformes	Callichthyidae	Corydoradinae	<i>Corydoras aeneus</i> (Gill, 1858)
		Callichthyinae	<i>Hoplosternum littorale</i> ** (Hancock, 1828)
	Loricariidae	Hypoptopomatinae	<i>Curculionichthys insperatus</i> (Britski & Garavello, 2003)
			<i>Hisonotus francirochai</i> (Ihering, 1928)
			<i>Hisonotus marapoama</i> ** (Ribeiro, Carvalho & Melo, 2005)
	Loricariidae	Hypostominae	<i>Hypostomus ancistroides</i> (Ihering, 1911)
			<i>Hypostomus iheringii</i> ** (Regan, 1908)
			<i>Hypostomus regani</i> (Ihering, 1905)
			<i>Cetopsorhamdia iheringi</i> ** Schubart & Gomes, 1959
	Heptapteridae		<i>Pimelodella avanhandavae</i> Eigenamn, 1917
			<i>Rhamdia quelen</i> ** (Quoy & Gaimard, 1824)
			<i>Cichlasoma paranaense</i> ** Kullander, 1983
			<i>Crenicichla jaguarensis</i> Haseman, 1911
Cichliiformes	Cichlidae		<i>Geophagus brasiliensis</i> (Quoy & Gaimard, 1824)
			<i>Satanoperca</i> sp.* **
Cyprinodontiformes	Poeciliidae		<i>Phalloceros harpagos</i> Lucinda, 2008
			<i>Poecilia reticulata</i> * Peters, 1859

Family Characidae  
Subfamily Stethaprioninae

*Astyanax lacustris* (Lütken, 1875)

Figure 3L

**Original description.** *Tetragonopterus lacustris* Lütken 1875: 131.

**Material examined.** BRAZIL • 1, 55.6 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26479) • 1, 59.3 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26487) •1, 31.1 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26527) • 4, 39.0–66.2 mm SL; São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26613).

**Identification.** Body deep; mouth terminal; premaxillary

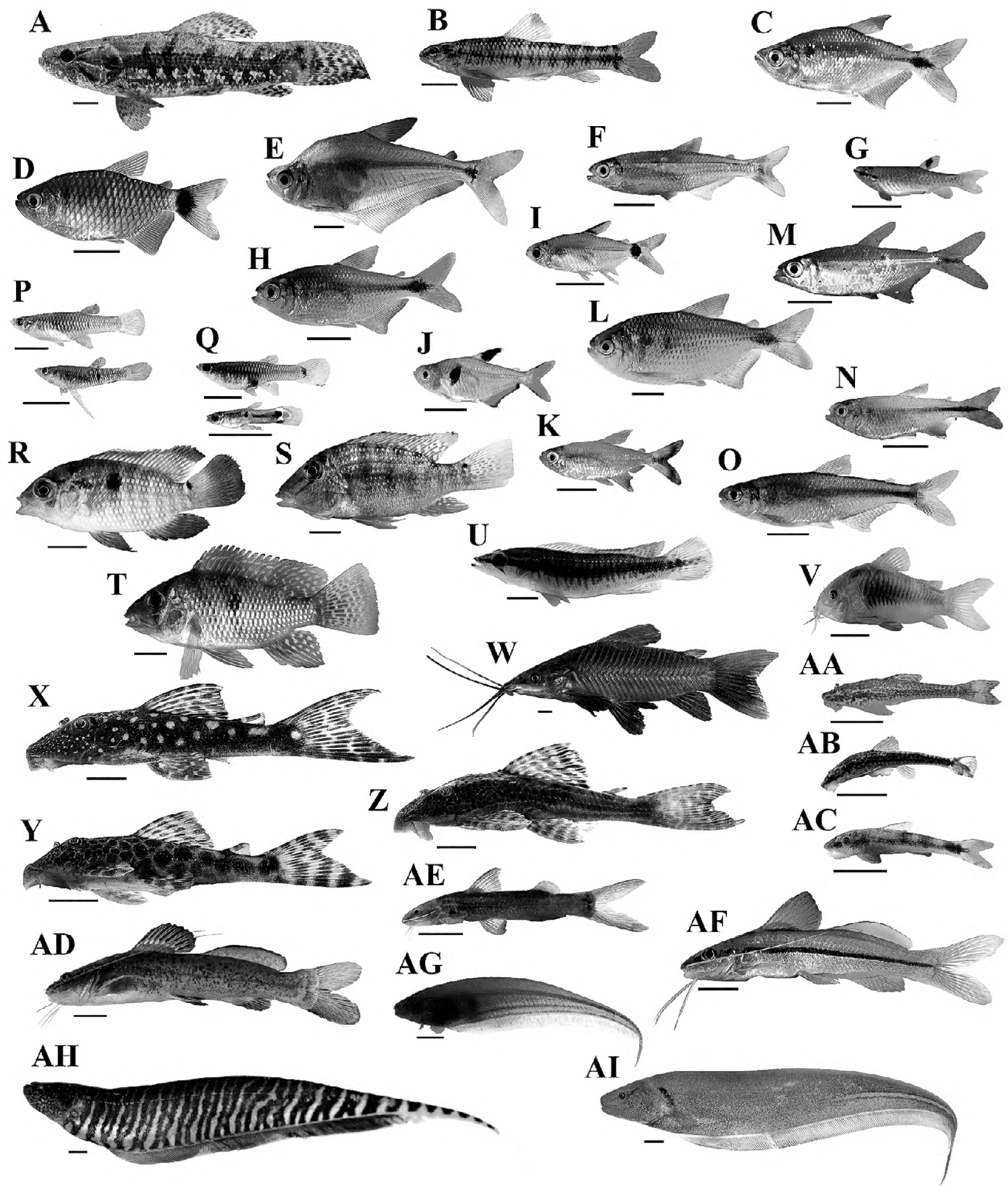
teeth in two rows, inner row with five four- to pentacuspidate teeth, outer row with four tricuspidate teeth; maxilla toothless; dentary with four anteriormost teeth larger, tetra- to pentacuspidate. Lateral line complete with 35 to 37 perforated scales; six or seven horizontal scale rows above lateral line; five or six horizontal scale rows below lateral line. Overall body coloration silver; two vertical conspicuous dark humeral blotches, anterior humeral blotch overlapped by another markedly horizontally oval blotch; caudal peduncle with horizontal oval dark blotch extending into middle caudal-fin rays; dorsal portion of eyes and fins yellowish.

*Psalidodon anisitsi* (Eigenmann, 1907)

Figure 3H

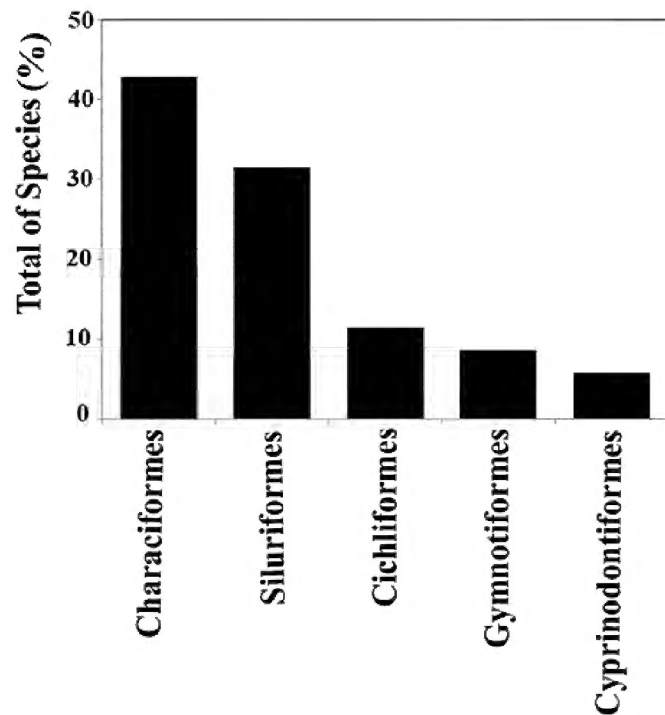
**Original description.** *Hemigrammus anisitsi* Eigenmann in Eigenmann and Ogle 1907: 16.

**Material examined.** BRAZIL • 2, 34.4–42.7 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L.

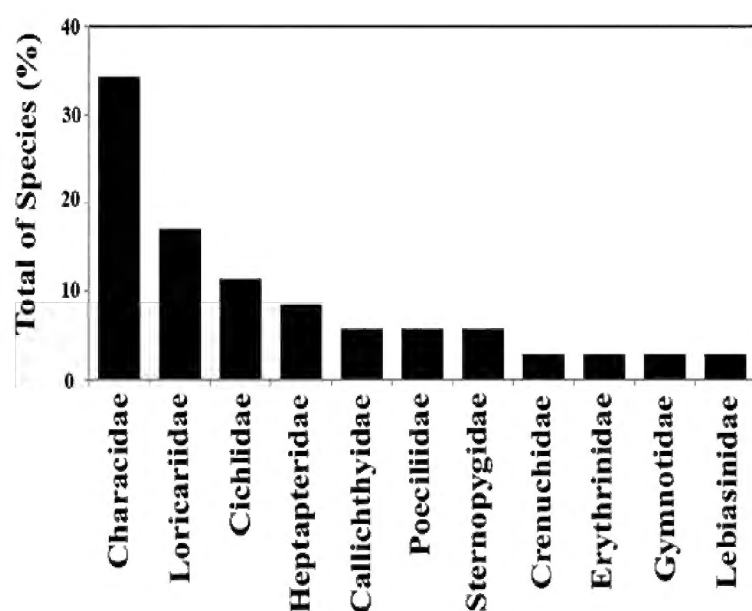


**Figure 3.** Species grouped by order: A–O Characiformes, P–Q Cyprinodontiformes, R–U Cichliformes, V–AF Siluriformes, and AG–AI Gymnotiformes in ribeirão Sucuri basin, rio Tietê-Batalha sub-basin, upper rio Paraná basin. **A.** *Hoplias misionera*, LBP 26478, 120.2 mm SL. **B.** *Characidium* aff. *zebra*, LBP 26477, 57.7 mm SL. **C.** *Oligosarcus pinto*, LBP 26516, 53.7 mm SL. **D.** *Moenkhausia* cf. *sanctaeofilomenae*, LBP 26510, 40.6 mm SL. **E.** *Roeboides descalvadensis*, LBP 26502, 69.3 mm SL. **F.** *Piabarchus stramineus*, LBP 26497, 47.6 mm SL. **G.** *Pyrrhulina australis*, LBP 26530, 23.9 mm SL. **H.** *Psalidodon anisitsi*, LBP 26486, 38.1 mm SL. **I.** *Serrapinnus notomelas*, LBP 26512, 21.0 mm SL. **J.** *Hyphessobrycon eques*, LBP 26509, 28.6 mm SL. **K.** *Moenkhausia bonita*, LBP 26511, 29.6 mm SL. **L.** *Astyanax lacustris*, LBP 26487, 56.5 mm SL. **M.** *Psalidodon* aff. *fasciatus*, LBP 26612, 42.8 mm SL. **N.** *Psalidodon paranae*, LBP 34.3 mm SL. **O.** *Piabina argentea*, LBP 26472, 51.5 mm SL. **P.** *Phalloceros harpagos*, LBP above 26.1 mm SL, female and below 16.7 mm SL, male. **Q.** *Poecilia reticulata*, LBP 27.2 mm SL, above female and below 13.2 mm SL, male. **R.** *Cichlasoma paranaense*, LBP 26492, 56.4 mm SL. **S.** *Satanoperca* sp., LBP 26531, 59.0 mm SL. **T.** *Geophagus brasiliensis*, LBP 26615, 58.8 mm SL. **U.** *Crenicichla jaguarensis*, LBP 26492, 51.8 mm SL. **V.** *Corydoras aeneus*, LBP 26499, 39.8 mm SL. **W.** *Hoplosternum littorale*, LBP 26617, 160.0 mm SL. **X.** *Hypostomus regani*, LBP 26490, 73.5 mm SL. **Y.** *Hypostomus iheringii*, LBP, 26491, 57.0 mm SL. **Z.** *Hypostomus ancistroides*, LBP 26521, 71.7 mm SL. **AA.** *Hisonotus marapoama*, LBP 26525, 28.3 mm SL. **AB.** *Hisonotus francirochai*, LBP 26471, 31.4 mm SL. **AC.** *Curculionichthys insperatus*, LBP 26526, 24.2 mm SL. **AD.** *Rhamdia quelen*, LBP 26470, 98.2 mm SL. **AE.** *Cetopsorhamdia iheringi*, LBP 26485, 60.5 mm SL. **AF.** *Pimelodella avanhandavae*, LBP 26496, 71.3 mm SL. **AG.** *Eigenmannia guairaca*, LBP 26503, 120.0 mm TL. **AH.** *Sternopygus macrurus*, LBP 26504, 219.6 mm TL. **AI.** *Gymnotus* cf. *cuia*, LBP26505, 260.2 mm TL. Scale bars = 1 cm.

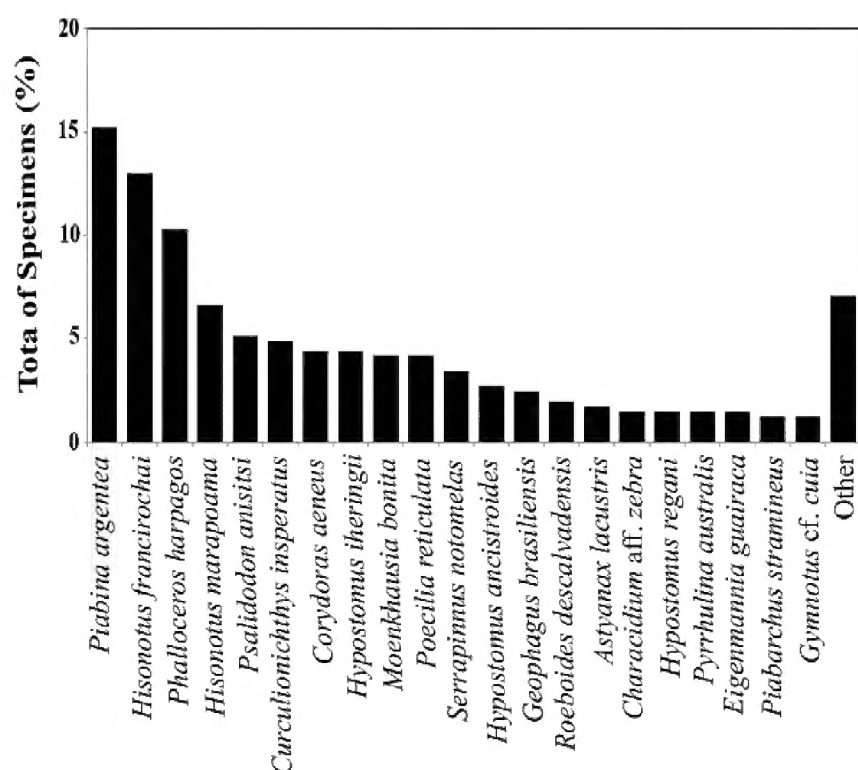
(LBP 26480) • 3, 33.0–36.1 mm SL; São Paulo state, Pongai, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26486) • 16, 19.3–41.8 mm SL; São Paulo state, Pongai, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26618).



**Figure 4.** Percentages of the total number of sampled species, by order, in ribeirão Sucuri.



**Figure 5.** Percentages of the total number of sampled species, by family, in ribeirão Sucuri.



**Figure 6.** Percentages of number of specimens of each species with more than five individuals captured in ribeirão Sucuri.

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with five penta- to heptacuspitate teeth, outer row with two tricuspidate teeth; one tricuspidate tooth on maxilla; dentary with four or five anteriormost teeth larger, tri- to pentacuspitate. Lateral line incomplete with nine to 18 perforated scales; longitudinal series with 31 to 36 scales; six horizontal scale rows above lateral line, four horizontal scale rows below lateral line. Overall body coloration silver; two conspicuous vertical dark humeral blotches; horizontal oval dark spot on caudal peduncle extending over middle caudal-fin rays; dorsal portion of eyes and fins (except dorsal fin) reddish.

#### *Psalidodon aff. fasciatus* (Cuvier, 1819)

Figure 3M

**Original description.** *Chalceus fasciatus* Cuvier 1819: 352.

**Material examined.** BRAZIL • 4, 30.7–42.6 mm SL; São Paulo state, Pongai, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26612).

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with five pentacuspitate teeth, outer row with four tricuspidate teeth; one tricuspidate tooth on maxilla; dentary with four anteriormost teeth larger, tri- to pentacuspitate. Lateral line complete with 37 to 38 perforated scales; six horizontal scale rows above lateral line; five horizontal scale rows below lateral line. Overall body coloration silver; conspicuous midlateral silver stripe extending from posterior margin of opercle to caudal peduncle; horizontal oval dark spot on caudal peduncle extending to middle caudal-fin rays; dorsal portion eyes yellowish; reddish fins.

#### *Psalidodon paranae* (Eigenmann, 1914)

Figure 3N

**Original description.** *Astyanax scabripinnis paranae* Eigenmann 1914: 47.

**Material examined.** BRAZIL • 1, 35.2 mm SL; São Paulo state, Pongai, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26481).

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with five hexa- to heptacuspitate teeth, outer row with three tricuspidate teeth; one tricuspidate tooth on maxilla; dentary with four anteriormost larger teeth, tri- to pentacuspitate. Lateral line complete with 36 perforated scales; five horizontal scale rows above lateral line; three horizontal scale rows below lateral line. Overall body coloration yellowish; two vertical dark humeral blotches, anterior blotch conspicuous and posterior blotch inconspicuous; conspicuous midlateral dark stripe from anterior margin of second humeral blotch to middle caudal-fin rays; caudal peduncle with horizontally oval dark spot; dorsal portion of eyes and fins orange.

***Hyphessobrycon eques* (Steindachner, 1882)**

Figure 3J

**Original description.** *Chirodon eques* Steindachner 1882: 179.

**Material examined.** BRAZIL • 3, 26.0–28.9 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26509).

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with six tri- to pentacuspitate teeth, outer row with two tricuspidate teeth; two to three tricuspidate teeth on maxilla; dentary with five or six anteriormost teeth larger, tri- to pentacuspitate. Lateral line incomplete with six or seven perforated scales; longitudinal series with 31 to 33 scales; six horizontal scale rows above lateral line; four horizontal scale rows below lateral line. Overall body coloration reddish; conspicuous dark blotch on dorsal-fin; conspicuous vertical dark humeral blotch; dorsal and ventral margin of caudal fin lobes dark; distal margin of anal-fin with a conspicuous dark stripe; dorsal portion of eyes and fins red.

***Moenkhausia bonita* Benine, Castro & Sabino, 2004**

Figure 3K

**Original description.** *Moenkhausia bonita* Benine et al. 2004: 68.

**Material examined.** BRAZIL • 9, 24.7–28.2 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26528) • 8, 15.6–29.5 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26511).

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with five to six tetra- to pentacuspitate teeth, outer row with four tricuspidate teeth; one to three tricuspidate teeth on maxilla; dentary with four anteriormost teeth larger, tri- to pentacuspitate. Lateral line incomplete with eight to ten perforated scales; longitudinal series with 32 or 33 scales; six horizontal scale rows above lateral line; three horizontal scale rows below lateral line. Overall body coloration silver to yellowish; silver midlateral stripe from anterior margin of opercle faint to caudal peduncle; caudal peduncle with a black lozenge-shaped spot extending to first half of middle caudal-fin rays; distal margin of both caudal-fin lobes black, except for their tips; dorsal portion of eyes orange; fins yellowish to reddish.

**Remarks.** The specimens did not present a complete lateral line, as observed in the original description (Benine et al. 2004). However, Vanegas-Ríos et al. (2019) analyzed populations of *M. bonita* from the Bermejo, Paraná, Paraguay, and Uruguay basins and determined that observed differences in body shape and completeness of lateral line are intraspecific variations. *Hemigrammus marginatus* Ellis, 1911 was the name used for

the specimens from upper rio Paraná; however, Ota et al. (2015) restricted this species to the basin of the rio São Francisco and rivers of northeastern Brazil. It is possible specimens of *Hemigrammus marginatus* collected by Serra et al. (2015) are *M. bonita*.

***Moenkhausia cf. sanctaefilomenae* (Steindachner, 1907)**

Figure 3D

**Original description.** *Tetragonopterus sanctaefilomenae* Steindachner 1907: 82.

**Material examined.** BRAZIL • 1, 40.6 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26510).

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with five pentacuspitate teeth, outer row with three tricuspidate teeth; two tricuspidate teeth on maxilla; dentary with five anteriormost teeth larger, tri- to pentacuspitate. Lateral line complete with 25 perforated scales; four horizontal scale rows above lateral line; four horizontal scale rows below lateral line. Overall body coloration silver; dark chromatophores concentrated on distal margin of scales resulting in conspicuous reticulated pattern; conspicuous vertical dark humeral blotch; caudal peduncle with conspicuous dark spot extending to base of caudal-fin, preceded by a lighter area; dorsal portion of eyes red; yellowish fins.

**Remarks.** Specimens collected in the ribeirão Sucuri have a complete lateral line, as in *M. australis* Eigenmann, 1908, but they differ in the number of transversal scale rows above and below lateral line (4 vs 5). Reia et al. (2019) identified the specimens of the so-called *Moenkhausia oligolepis* group from the upper Paraná basin (except from Mato Grosso do Sul state) as *Moenkhausia cf. sanctaefilomenae* by presenting a variable number of transversal scale series and an interrupted lateral line. This criterion is adopted herein. The *M. oligolepis* group is being taxonomically revised by the first author.

***Oligosarcus pinto* Amaral Campos, 1945**

Figure 3C

**Original description.** *Oligosarcus pinto* Amaral Campos 1945: 456.

**Material examined.** BRAZIL • 1, 29.9 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26506) • 1, 54.9 mm SL; São Paulo state, Pongaí, Córrego Saltinho; 21°44'02"S, 049°21'18"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26516) • 1, 69.3 mm SL; São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26619).

**Identification.** Body somewhat deep; mouth terminal; premaxilla with three larger teeth, tri- to pentacuspitate and six smallest teeth, tricuspidate in a single row; 19 or 20 tricuspidate teeth on maxilla; dentary with four anteriormost teeth larger, tri- to pentacuspitate. Lateral line complete with 38 perforated scales; seven or eight horizontal scale rows above lateral line; five horizontal scale rows below lateral line. Overall body coloration silver; conspicuous vertical dark humeral blotch followed by a second inconspicuous humeral blotch; narrow midlateral dark stripe from anterior margin of second humeral blotch to caudal peduncle; caudal peduncle with horizontally-oval dark spot extending into middle caudal-fin rays; dorsal portion of eyes and fins yellowish; dorsal fin orange.

Subfamily Stevardiinae

***Piabarchus stramineus* (Eigenmann, 1908)**

Figure 3F

**Original description.** *Bryconamericus stramineus* Eigenmann 1908: 105.

**Material examined.** BRAZIL • 2, 46.3–47.0 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26497) • 3, 38.4–42.6 mm SL; São Paulo state, Pongaí, Córrego da Aldeia; 21°42'57"S, 049°21'26"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26513).

**Identification.** Body deep; mouth terminal; premaxillary teeth in two rows, inner row with four pentacuspitate teeth, outer row with three to five tricuspidate teeth; one to two tricuspidate teeth on maxilla; dentary with four anteriormost teeth larger, pentacuspitate. Lateral line complete with 39 to 41 perforated scales; five horizontal scale rows above lateral line; three horizontal scale rows below lateral line. Overall body coloration silver to yellowish; conspicuous midlateral silver stripe from posterior margin of opercle to caudal-fin base; dark stripe in middle caudal-fin rays; dorsal, pectoral, pelvic, anal, and caudal fins hyaline; adipose fin yellowish; margins of dorsal and ventral portion of caudal-fin lobes yellowish.

***Piabina argentea* Reinhardt, 1867**

Figure 3O

**Original description.** *Piabina argentea* Reinhardt 1867: 50.

**Material examined.** BRAZIL • 40, 20.4–50.6 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26472) • 14, 21.0–52.5 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26484) • 1, 36.4 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26498) • 7, 28.2–55.6 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S,

049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26507).

**Identification.** Body deep; mouth subterminal; premaxillary teeth in three rows, outer row of premaxilla with three tricuspidate teeth, median row with two tricuspidate teeth, inner row with four tri- to tetracuspitate teeth; two or three tricuspidate teeth on maxilla; dentary with four anteriormost teeth larger, tricuspidate. Lateral line complete with 38 to 40 perforated scales; four or five horizontal scale rows above lateral line; three horizontal scale rows below lateral line. Overall body coloration silver; conspicuous dark vertical humeral blotch; conspicuous midlateral silver stripe from posterior margin of opercle to middle caudal-fin rays; dorsal, pectoral, pelvic, anal, and adipose fins hyaline; caudal fin yellowish.

Subfamily Cheirodontinae

***Serrapinnus notomelas* (Eigenmann, 1915)**

Figure 3I

**Original description.** *Cheirodon notomelas* Eigenmann 1915: 74.

**Material examined.** BRAZIL • 1, 20.9 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26512) • 3, 21.5–29.1 mm SL; São Paulo state, Pongaí, Córrego Saltinho; 21°44'02"S, 049°21'18"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26518) • 10, 17.3–27.6 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26529).

**Identification.** Body deep; mouth terminal; premaxilla with five penta- to heptacuspitate teeth in a single row; two hepta- to octacuspitate teeth on maxilla; dentary with six or seven octacuspitate teeth. Lateral line incomplete with seven or eight perforated scales; longitudinal series with 31 to 34 scales; five horizontal scale rows above lateral line; four horizontal scale rows below lateral line. Overall body coloration silver to orange; narrow midlateral dark stripe from posterior margin of opercle to caudal peduncle; caudal peduncle with conspicuous dark spot extending to base of caudal-fin rays; dorsal fin with first rays and basal portion dark; pectoral, pelvic, anal, adipose, and caudal fins yellowish to orange; two yellowish patches on dorsal and ventral caudal-fin lobes.

Subfamily Characinae

***Roeboides descalvadensis* Fowler, 1932**

Figure 3E

**Original description.** *Roeboides descalvadensis* Fowler 1932: 359.

**Material examined.** BRAZIL • 6, 55.5–72.5 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26502) • 2, 26.8–41.8 mm SL; São Paulo state,

Pongaí, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26622).

**Identification.** Body deep; mouth terminal; all teeth conical, premaxillary teeth in two rows, inner row with five or six teeth, outer row with six or seven teeth; eight to 12 teeth on maxilla; dentary teeth in two rows, inner row with eight to 11 teeth, outer row with two teeth. Lateral line complete with 66 to 69 perforated scales; 13 or 14 horizontal scale rows above lateral line; nine or ten horizontal scale rows below lateral line. Overall body coloration silver; small rounded conspicuous dark humeral blotch; conspicuous silver midlateral stripe from humeral blotch to caudal peduncle; caudal peduncle with conspicuous rounded elongate dark spot; distal margin of dorsal fin with conspicuous dark stripe; dorsal portion of eyes yellowish; fins hyaline.

Order Gymnotiformes

Family Gymnotidae

***Gymnotus cf. cuia* Craig, Malabarba, Crampton & Albert, 2018**

Figure 3AH

**Original description.** *Gymnotus cuia* Craig et al. 2018: 55.

**Material examined.** BRAZIL • 2, 164.7–254.0 mm TL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26505) • 1, 80.0 mm TL; São Paulo state, Uru, Córrego da Pata; 21°43'49"S, 049°18'38"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26520) • 2, 92.9–201.2 mm TL; São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26616).

**Identification.** Body elongated and compressed; mouth superior; premaxilla with nine to 15 teeth in a single row; dentary with 14 to 22 teeth; lower jaw extending beyond upper one. Eyes below horizontal midline. Anal fin with 160 to 198 total rays. Scales cycloid and ovoid; six horizontal scale rows above lateral line, seven to eight horizontal scale rows below lateral line. Overall body coloration yellowish; 25 or 26 oblique dark bands, majority of dark bands paired with pale middle region (in-traband); hyaline fins.

**Remarks.** According to Craig et al. (2018), two species occur in the rio Tietê basin: *Gymnotus inaequilabiatus*, which belongs to *G. tigre* clade, and *G. cuia*, part of the *G. carapo* clade. The specimens collected here present a clear patch of anal-fin membrane near the caudal end, a characteristic shared with the members of *G. carapo* clade (Craig et al. 2018), suggesting that this species is *G. cuia*. However, the samples from ribeirão Sucuri present fewer dentary teeth, 14–22 (vs 26–27 in *G. cuia*). Therefore, we prefer to identify the samples from ribeirão Sucuri as *Gymnotus cf. cuia*.

Family Sternopygidae

***Eigenmannia guairaca* Peixoto, Dutra & Wosiacki, 2015**

Figure 3AG

**Original description.** *Eigenmannia guairaca* Peixoto et al. 2015: 394.

**Material examined.** BRAZIL • 1, 158.6 mm TL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LB 26493). Brazil • 5, 48.1–131.8 mm TL; São Paulo State, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26503).

**Identification.** Body elongated and compressed; mouth terminal; premaxillary teeth in two rows, innermost with five teeth, outermost row with four teeth; dentary teeth in two rows, innermost with five or six teeth, outermost with eight or nine teeth. Eye approximately circular, covered by skin, anal fin with 150 to 155 total rays. Scales cycloid; ten or 11 horizontal scale rows above lateral line. Overall body coloration light brown; four dark midlateral stripes along body: on dorsal region of body, on lateral line, on ventral-lateral portion of body, and one at anal-fin base.

***Sternopygus macrurus* (Bloch & Schneider, 1801)**

Figure 3AI

**Original description.** *Gymnotus macrurus* Bloch and Schneider 1801: 522.

**Material examined.** BRAZIL • 3, 199.6–226.2 mm TL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26504).

**Identification.** Body elongated and compressed; mouth terminal; all teeth conical, premaxilla and dentary with several small teeth arranged in irregular rows. Eyes above horizontal midline of body. Anal fin with 215 to 230 total rays. Scales cycloid; caudal filament narrow. Overall body coloration yellowish; conspicuous dark humeral blotch; cream-white narrow stripe from a vertical reaching 150° anal-fin ray to tip caudal-filament.

Order Siluriformes

Family Callichthyidae

Subfamily Corydoradinae

***Corydoras aeneus* (Gill, 1858)**

Figures 3V

**Original description.** *Hoplosoma aeneum* Gill 1858: 403.

**Material examined.** BRAZIL • 2, 39.7–39.9 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26499) • 1, 44.9 mm SL; São Paulo state, Pongaí, Córrego Água Grande; 21°41'31"S, 049°20'31"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26508) • 1, 29.9 mm SL; São Paulo state, Pongaí, Córrego Saltinho;

21°44'02"S, 049°21'18"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26517) • 6, 33.8–42.4 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26522) • 3, 33.9–40.1 mm SL; São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26614) • 5, 28.0–33.4 mm SL; São Paulo state, Uru, Córrego da Pata; 21°43'49"S, 049°18'38"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26652).

**Identification.** Body deep; mouth inferior; maxillary barbel short, not reaching pectoral-fin base. Body plates with minute odontodes restricted to posterior margins; lateral body plates in two longitudinal rows; dorsolateral rows with 21 or 22 plates; ventrolateral rows with 20 or 21 plates; trunk lateral line with three laterosensory canals on dorsal series plates. Overall body coloration dark green on dorsal portion, and yellowish to orange ventrally; dorsal portion of head, and opercular and lateral cleithral area golden; yellowish fins.

Subfamily Callichthyinae

### *Hoplosternum littorale* (Hancock, 1828)

Figure 3W

**Original description.** *Callichthys littoralis* Hancock 1828: 244.

**Material examined.** BRAZIL • 2, 73.8–125.0 mm SL; São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 049°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26617).

**Identification.** Body deep; mouth inferior; maxillary barbel long, surpassing gill opening. Body plates with minute odontodes restricted to posterior margins; lateral body plates in two longitudinal rows; dorsolateral rows with 23 or 24 plates; ventrolateral rows with 22 or 23 plates. Caudal fin bifurcated. Overall body coloration dark green to gray; darker fins.

Family Loricariidae

Subfamily Hypostominae

### *Hypostomus ancistroides* (Ihering, 1911)

Figure 3Z

**Original description.** *Plecostomus ancistroides* Ihering 1911: 396.

**Material examined.** BRAZIL • 1, 43.2 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26482) • 3, 35.8–70.5 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26495) • 7, 35.3–45.5 mm SL; São Paulo state, Uru, Córrego da Pata; 21°43'49"S, 049°18'38"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26521).

**Identification.** Body elongated; mouth ventral; maxillary barbel long, slender, and free distally; teeth slender

and bicuspid, central cusp larger than lateral; premaxilla with 38 to 46 teeth; dentary with 36 to 43 teeth; body covered by odontodes. Body completely covered by bone plates, median series with 25 perforated plates by lateral line; cleithrum and coracoid not exposed; abdomen naked. Overall body coloration light-brown; head with many small dark spots, four dark saddles along dorsal portion of body: first at dorsal-fin base, second at end of dorsal-fin base, third at middle of caudal peduncle, and fourth reaching anteriormost caudal procurent rays; fins hyaline with dark stripes.

### *Hypostomus iheringii* (Regan, 1908)

Figure 3Y

**Original description.** *Plecostomus iheringii* Regan 1908: 795.

**Material examined.** BRAZIL • 12, 22.9–51.2 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26476) • 5, 36.9–67.6 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26491) • 1, 81.0 mm SL; São Paulo state, Pongaí, Córrego da Aldeia; 21°42'57"S, 049°21'26"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26514).

**Identification.** Body elongated; mouth ventral; maxillary barbel long, slender, and free distally; teeth slender and bicuspid, central cusp larger than lateral; premaxilla with 24 to 32 teeth; dentary with 26 to 34 teeth. Body covered by odontodes; body completely covered by bone plates, median series with 26 perforated plates by lateral line; cleithrum and coracoid not exposed; abdomen entirely plated; with smaller platelets forming a shield. Overall body coloration light brown; head with many small dark spots, spots becoming larger on posterior portion of head, continuing on body, becoming gradually larger toward caudal peduncle; fins hyaline with dark stripes.

### *Hypostomus regani* (Ihering, 1905)

Figure 3X

**Original description.** *Plecostomus regani* Ihering 1905: 558.

**Material examined.** BRAZIL • 2, 58.7–70.3 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26475) • 4, 56.8–116.7 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26490).

**Identification.** Body elongated; mouth ventral; maxillary barbel long, slender, and free distally; teeth slender and bicuspid, central cusp larger than lateral; premaxilla with 50 to 61 teeth; dentary with 52 to 66 teeth; body covered by odontodes. Body completely covered by bone plates, median series with 26 perforated plates by lateral line; cleithrum and coracoid not exposed; abdomen partially covered by plates; lateral abdomen plates smaller

and rounded; median platelets rounded and forming abdominal shield. Overall body coloration darkened; head with many small yellow spots, spots becoming larger on posterior portion of head, continuing and becoming gradually larger toward caudal peduncle; fins dark with large light round spots.

Subfamily Hypoptopomatinae

***Curculionichthys insperatus* (Britski & Garavello, 2003)**

Figure 3AC

**Original description.** *Hisonotus insperatus* Britski and Garavello 2003: 588.

**Material examined.** BRAZIL • 1, 21.0 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26473) • 7, 20.1–25.1 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26500) • 12, 14.5–25.3 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26526).

**Identification.** Body elongated; mouth ventral; maxillary barbel short, slender, and free distally; teeth slender and bicuspid, central cusp larger than lateral; premaxilla with ten or 11 teeth; dentary with eight to ten teeth; body covered by odontodes. Body completely covered by bone plates, median plates series with 22 or 23 perforated by lateral line; cleithrum and coracoid completely exposed; abdomen entirely covered by plates; lateral abdomen plates larger and forming regular rows of six to seven elongated plate on each sides; median abdominal plates smaller, irregularly arranged and formed by one row of plate. Overall body coloration whitish; four dark saddles along dorsal portion of body: midlateral dark strip from posterior margin of orbit to caudal peduncle; hyaline fins; caudal fin blotch in median caudal-fin rays, and patches of dark chromatophores in dorsal and ventral lobes.

***Hisonotus francirochai* (Ihering, 1928)**

Figure 3AB

**Original description.** *Otocinclus francirochai* Ihering 1928: 2.

**Material examined.** BRAZIL • 52, 19.4–29.3 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26471) • 1, 31.5 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26483).

**Identification.** Body elongated; mouth ventral; maxillary barbel short, slender and free distally; teeth slender and bicuspid, central cusp larger than lateral; premaxilla with 17 to 21 teeth; dentary with 16 to 22 teeth. Body covered by odontodes; odontodes of snout larger in size than remaining in head; tuft of enlarged odontodes on

posterior tip of parieto-supraoccipital; odontodes on head and trunk well defined, randomly arranged; body completely covered by bone plates, median series 24 or 25 perforated plates by lateral line; cleithrum and coracoid completely exposed; abdomen partially covered by plates; lateral abdomen plates larger and forming regular rows of three or four elongated plate on each sides; median abdominal plate absent; small anal plates present. Overall body coloration darkened; dorsal, anal, pectoral, and pelvic fins hyaline; caudal fin black with two rounded hyaline areas, large on dorsal and small on ventral lobes.

***Hisonotus marapoama* (Ribeiro, Carvalho & Melo, 2005)**

Figure 3AA

**Original description.** *Otothyropsis marapoama* Ribeiro, Carvalho and Melo 2005: 491.

**Material examined.** BRAZIL • 27, 15.5–29.9 mm SL; São Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26525).

**Identification.** Maxillary barbel short; slender and free distally; teeth slender and bicuspid, central cusp larger than lateral cusps; premaxilla with 16 to 20 teeth; dentary with 12 to 16 teeth. Body covered by odontodes; odontodes of snout larger in size than remaining in head; odontodes on head and trunk well defined, randomly arranged; body completely covered by bone plates; median series 21 to 23 plates by lateral line; lateral line truncated, terminating in three or four unperforated plates; cleithrum and coracoid completely exposed; abdomen entirely covered by large plates. Overall body coloration greenish, with vermiculated white spots; dorsal, anal, pectoral, and pelvic yellowish with five or six dark stripes; dorsal caudal-fin lobe greenish, with two rounded hyaline area on dorsal and ventral lobes.

Subfamily Heptapteridae

***Cetopsorhamdia iheringi* Schubart & Gomes, 1959**

Figure 3AE

**Original description.** *Cetopsorhamdia iheringi* Schubart and Gomes 1959: 1.

**Material examined.** BRAZIL • 1, 60.5 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26485).

**Identification.** Body elongated; mouth terminal; all teeth villiform, premaxillary and dentary teeth arranged in irregular rows; maxillary barbel reaching base of last pectoral-fin rays; outer and inner mental barbel reaching gill opening; anterior nostril tubular. Overall body coloration light brown; yellowish color on posterior portion of dorsal head; hyaline fins.

***Pimelodella avanhandavae* Eigenmann, 1917**

Figure 3AF

**Original description.** *Pimelodella avanhandavae* Eigenmann 1917: 240.

**Material examined.** BRAZIL • 2, 37.2–71.3 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26496).

**Identification.** Body elongated; mouth terminal; all teeth villiform, premaxillary and dentary teeth arranged in irregular rows; maxillary barbel reaching base of last pectoral-fin ray; outer and inner mental barbels long, reaching adipose-fin origin; anterior nostril tubular. Overall body coloration silver to light brown; dark midlateral stripe from upper lip to caudal peduncle; dorsal fin with dark brown stripe on its base; distal portion of dorsal and adipose fins dark; remaining fins hyaline to orange.

***Rhamdia quelen* (Quoy & Gaimard, 1824)**

Figure 3AD

**Original description.** *Pimelodus quelen* Quoy and Gaimard 1824: 228.

**Material examined.** BRAZIL • 1, 98.2 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26470).

**Identification.** Body elongated; mouth terminal; all teeth villiform, premaxillary and dentary teeth arranged in irregular rows; maxillary barbel reaching base of last pectoral-fin ray; outer and inner mental barbels long, reaching adipose-fin origin; anterior nostril tubular. Overall body coloration yellowish with scattered dark brown chromatophores; dorsal fin with interradiat membranes dark; remaining fins yellowish, with dark chromatophores along of margins.

Order Cichliformes

Family Cichlidae

***Cichlasoma paranaense* Kullander, 1983**

Figure 3R

**Original description.** *Cichlasoma paranaense* Kullander 1983: 241.

**Material examined.** BRAZIL • 1, 56.4 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26492).

**Identification.** Body deep; mouth terminal; premaxilla with three and dentary with four teeth rows. Upper lateral line with 17 perforated scales; lower lateral line with nine perforated scales; longitudinal series with 25 scales; three horizontal scale rows above upper lateral line; five horizontal scale rows below lower lateral line. Overall body coloration silver to yellowish; two dark blotches just below upper lateral line, one on humeral region and

other on mid-body; nine conspicuous dark bars on body; smaller vertical dark spot on dorsal region of caudal peduncle; eyes red; yellowish fins.

***Crenicichla jaguarensis* Haseman, 1911**

Figure 3U

**Original description.** *Crenicichla jaguarensis* Haseman 1911: 351.

**Material examined.** BRAZIL • 2, 52.4–59.1 mm SL; São Paulo state, Pongaí, Ribeirão Sucuri; 21°44'19"S, 049°21'56"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26494).

**Identification.** Body elongated; mouth terminal; premaxillary and dentary teeth in several rows. Upper lateral line with 26 perforated scales; lower lateral line with 11 or 12 perforated scales; longitudinal series 47 to 49 scales; three horizontal scale rows above upper lateral line; eight horizontal scale rows below lower lateral line. Overall body coloration yellowish; 14 or 15 conspicuous dark bars; conspicuous midlateral dark stripe from upper lip to middle caudal-fin rays; short transversal stripe below orbital area; fins hyaline with dark spots.

***Geophagus brasiliensis* (Quoy & Gaimard, 1824)**

Figure 3T

**Original description.** *Chromis brasiliensis* Quoy and Gaimard 1824: 286.

**Material examined.** BRAZIL • 10, 30.2–60.7 mm SL; São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 049° 21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26615).

**Identification.** Body deep; mouth terminal; premaxilla with three and dentary with two to four teeth rows. Upper lateral line with 18 to 20 perforated scales; lower lateral line with 11 to 13 perforated scales; longitudinal series with 26 to 29 scales; four horizontal scale rows above upper lateral line; five horizontal scale rows below lower lateral line. Overall body coloration silver to greenish; six to eight conspicuous dark bars; dark conspicuous blotch in middle-body; dark vertical bar across eye; longitudinal blue stripes rows on trunk; blue blotches on head and fins; eyes and fins reddish.

**Remarks.** Our results showed variation in the number of pored scales of the upper lateral line and total scales in the longitudinal series of *G. brasiliensis* in comparison to the description by Ota et al. (2018) for specimens from the upper rio Paraná floodplains (18–20 vs 17–19 and 26–29 vs 24–27, respectively). We also observed a single specimen with 13 pored scales in the upper lateral line and a non-pored lower lateral line. Our observations increase the known range for these counts in *G. brasiliensis* in the the upper rio Paraná.

***Satanoperca* sp.**

Figure 3S

**Material examined.** BRAZIL • 1, 59.0 mm SL; São

Paulo state, Pongaí, Ribeirão Sucurizinho; 21°43'39"S, 049°18'54"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26531).

**Identification.** Body deep; mouth terminal; one row of teeth on premaxilla and dentary. Upper lateral line with 17 perforated scales; lower lateral line with 11 perforated scales; longitudinal series with 27 scales; four horizontal scale rows above upper lateral line; six horizontal scale rows lower lateral line; Overall body coloration greenish; 10 conspicuous dark bars; small dark spot on anterodorsal portion of caudal fin; a conspicuous midlateral dark stripe from posterior margin of opercle to caudal peduncle; fins yellowish to orange with small rounded blue or clear areas; eyes yellowish to silver with bluish blotches.

**Remarks.** The species observed here is the same as found by Ota et al. (2018), also identified as *Satanoperca* sp.

Order Cyprinodontiformes

Family Poeciliidae

### *Phalloceros harpagos* Lucinda, 2008

Figure 3P

**Original description.** *Phalloceros harpagos* Lucinda 2008: 134.

**Material examined.** BRAZIL • 20 male, 12.7–21.2 mm SL, 20 female, 13.6–26.3 mm SL; São Paulo state, Pongaí, Córrego Santa Rosa; 21°46'29"S, 049°23'34"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26474) • 1 male, 17.8 mm SL, 1 female, 18.1 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 049°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26488) • 1 female, 14.5 mm SL; São Paulo state, Pongaí, Córrego Salinho; 21°44'02"S, 049°21'18"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26519) • 1 female 25.8 mm SL; São Paulo state, Uru, Córrego da Pata; 21°43'49"S, 049°18'38"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26523).

**Identification.** Body elongated; mouth superior; premaxilla and dentary with several small teeth, dentary prognathous. Lateral line unpored; nine transverse scale rows; longitudinal series with 29 to 31 scales. Overall body coloration yellowish; brown chromatophores concentrated on distal margin of scales resulting in conspicuous reticulated pattern; vertical elongated conspicuous brown mark on 16° to 18° scale on longitudinal row; males with elongated anal-fin rays; ventral portion of eyes reddish; yellowish fins.

### *Poecilia reticulata* Peters, 1859

Figure 3Q

**Original description.** *Poecilia reticulata* Peters 1859: 412.

**Material examined.** BRAZIL • 7 male, 12.0–13.3 mm SL, 3 female, 11.7–26.7 mm SL; São Paulo state, Pongaí, Córrego Zanata; 21°47'02"S, 49°22'44"W; 12 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26489). Brazil • 4 male, 12.9–14.7 mm SL, 4 female, 18.1–22.2 mm SL;

São Paulo state, Pongaí, Córrego da Mina; 21°43'45"S, 49°21'29"W; 24 May 2018; leg. Silva G.S.C. and Reia L. (LBP 26620).

**Identification.** Body elongated; mouth superior; premaxilla and dentary with several small teeth; dentary prognathous. Lateral line unpored; six to seven transverse scales rows; longitudinal series with 26 to 30 scales. Overall body coloration yellowish; brown chromatophores concentrated on distal margin of scales resulting in conspicuous reticulated pattern; males with upper caudal-fin rays prolonged and presenting a conspicuous black mark on central portion of end of caudal peduncle; irregular color blotches, and stripes along body; females with a dark blotch on caudal-fin base; yellowish to orange fins.

## Discussion

Characiformes and Siluriformes presented the greatest species richness, which corresponds to 74.2% of all collected species (Fig. 4). Our results agree with other ichthyofaunistic studies in the upper rio Paraná and other Neotropical rivers, which also found a high diversity of these two orders (e.g. Castro et al. 2004; Langeani et al. 2007; Vari et al. 2009; Esguícero and Arcifa 2011; Ohara and Loeb 2016). Indeed, Siluriformes and Characiformes are the most diverse groups of Neotropical freshwater fishes, followed by Gymnotiformes (Lowe-McConnell 1999; Fricke et al. 2020). These three orders represent 74% of the South American fish diversity (Reis et al. 2016).

We collected 35 species, a number very similar to previous ichthyofaunistic studies in headwaters of the upper rio Paraná basin (e.g. Pazian et al. 2011; Cetra et al. 2016; Azevedo-Santos et al. 2018; Batista-Silva et al. 2018; Claro-Garcia et al. 2018; Diniz et al. 2019). All species found here had already been reported for the upper rio Paraná basin (Langeani et al. 2007; Ota et al. 2018), which is represented by 310 species (Langeani et al. 2007).

Our study found *Eigenmannia guairaca*, a recently described species, which originally was only known from a small tributary in the rio Paranapanema basin (Peixoto et al. 2015). Nonetheless, Ota et al. (2018) listed *E. guairaca* for the floodplain regions of the upper rio Paraná and the rio Iguatemi, demonstrating that this species is more widespread in the upper rio Paraná. It is possible that specimens of *E. guairaca* have been previously identified as *E. trilineata* López & Castello, 1966 or *E. virescens* Valenciennes, 1836, such as by Pazian et al. (2011), in an inventory of fishes in the riacho Goulart, lower Tietê (LBP 9911; 11394). Another species that is reported for the first time in the Tietê basin is *Hoplias misionera*.

*Hypostomus iheringii*, although described from the rio Piracicaba, a tributary of the rio Tietê, has not been listed in previous ichthyofaunistic studies in the rio Tietê. Ota et al. (2019) listed this species in the floodplain

of the upper Paraná downstream from the mouth of the rio Tietê. The taxonomy of the genus *Hypostomus* is complex, with species quite similar, and specimens of *H. iheringii* were possibly misidentified in previous studies.

Four non-native species were recorded from the ribeirão Sucuri, *Hoplias misionera*, *Poecilia reticulata*, *Roeboidea descalvadensis*, and *Satanoperca* sp. According to Lucena (2007), *R. descalvadensis* is distributed in the Amazon, Paraguay, and lower and upper Paraná river basins. Langeani et al. (2007), however, pointed out that *R. descalvadensis* is non-native for the upper Paraná, and Julio Junior et al. (2009) argued that this species probably reached this portion of the river through the Canal da Piracema, a fish passage of the Itaipu Hydroelectric Power Plant. Fagundes et al. (2015) reported *R. descalvadensis* in the rio Paranaíba basin, demonstrating that after a few years this species reached the northern boundary of the upper rio Paraná. Accordingly, Costa-Silva et al. (2017) found no genetic divergence between samples of *R. descalvadensis* from the rio Tietê, upper rio Paraná, and rio Paraguay, as expected in populations transplanted by human activities, whether by the Canal da Piracema or by any other means. According to Ota et al. (2018), the presence of *H. misionera* and *Satanoperca* sp. in the upper rio Paraná is, as well, explained by the Canal da Piracema and filling of the Itaipu Reservoir.

*Poecilia reticulata*, another non-native species, has been introduced in the upper rio Paraná to aid in the control of larvae of mosquitoes (Ota et al. 2018). Some authors consider *Hyphessobrycon eques* to be native to the upper rio Paraná (Langeani et al. 2007); however, Marceniuk et al. (2011) argued that the presence of this species in the upper rio Tietê is due to pisciculture and ornamental fish trade.

*Piabina argentea*, with approximately 60 specimens captured, was the most abundant species in the ribeirão Sucuri. Serra et al. (2015) also found *P. argentea* to be the most abundant species in their study in the rio Cubatão, another tributary of the Tietê-Batalha sub-basin. According to Casatti et al. (2006), *P. argentea* occurs in less degraded habitats. *Piabina argentea* was especially abundant in the córrego Santa Rosa (40 specimens) and córrego Zanata (14 specimens), which is an indication of less degradation in these streams. Indeed, the córrego Santa Rosa was the sampling site where we captured the highest diversity, with 13 species (Table 3), suggesting that this stream should be a priority for conservation. Despite being a pasture area, as well as the others streams of ribeirão Sucuri, the córrego Santa Rosa presents the highest diversity of habitats, composed of lentic and lotic environments, and a portion with large area of riparian vegetation. This habitat complexity probably is responsible for the higher biodiversity (Ricklefs and Schluter 1994; Allan and Castillo 2007).

The species composition, as recorded by us, differed from other studies performed in the rio Tietê basin. The study by Esguícero and Arcifa (2011) in the rio Jacaré-Guaçu shares 22 species with our study. Other studies

had from seven to 18 species in common with our study (Uieda and Barreto 1999; Barrela and Petrere Jr. 2003; Castro et al. 2005; Langeani et al. 2005; Silva et al. 2006; Vidotto and Carvalho 2007; Marceniuk et al. 2011; Pazian et al. 2011; Serra et al. 2015). In addition, we found 14 species that were not reported by Serra et al. (2015) from the Tietê-Batalha sub-basin: *Cetopsorhamdia iheringii*, *Cichlasoma paranaense*, *Eigenmannia guairaca*, *Geophagus brasiliensis*, *Gymnotus* cf. *cuia*, *Hisonotus marapoama*, *Hoplosternum littorale*, *Hypostomus iheringii*, *Psalidodon anisitsi*, *P. paranae*, *Pyrhulina australis*, *R. descalvadensis*, *Rhamdia quelen*, *Satanoperca* sp., and *Sternopygus macrurus*. Therefore, different portions of the rio Tietê may harbor different species compositions and demand different conservation measures.

Our study, combined with that of Serra et al. (2015), reported 55 species from the Tietê-Batalha sub-basin and this association contributes to the understanding of the species structuring in the river basin. This provides valuable data for current and future conservation efforts as preconized by Bifi et al. (2017), in response to increasing and accelerate processes of natural habitat losses in the São Paulo state and the consequent damage to the ichthyofauna (Oyakawa and Menezes, 2011).

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## Authors' Contributions

LR, GSCS, AMPFV, and JRGA designed the idea of the research; LR and GSCS performed the fieldwork and description of species; LR, GSCS, and RCB identification of species and wrote the manuscript; all authors reviewed the text.

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**Table 3.** Species found by collection point in ribeirão Sucuri, middle rio Tietê, upper rio Paraná basin.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
<i>Characidium</i> aff. <i>zebra</i>	X		X						
<i>Pyrrhulina australis</i>				X					X
<i>Hoplias misionera</i>	X				X				X
<i>Astyanax lacustris</i>	X	X		X					X
<i>Psalidodon anisitsi</i>	X	X		X					
<i>Psalidodon</i> aff. <i>fasciatus</i>				X					
<i>Psalidodon paranae</i>	X								
<i>Hyphessobrycon eques</i>						X			
<i>Moenkhausia bonita</i>							X		X
<i>Moenkhausia</i> cf. <i>sanctaefilomenae</i>							X		
<i>Oligosarcus pinto</i>				X	X		X		
<i>Piabarchus stramineus</i>			X			X			
<i>Piabina argentea</i>	X	X	X				X		
<i>Serrapinnus notomelas</i>					X		X		X
<i>Roeboides descavadensis</i>			X	X					
<i>Gymnotus</i> cf. <i>cuia</i>				X			X	X	
<i>Eigenmannia guairaca</i>			X				X		
<i>Sternopygus macrurus</i>							X		
<i>Corydoras aeneus</i>			X	X	X		X	X	X
<i>Hoplosternum littorale</i>				X					
<i>Curculionichthys insperatus</i>	X		X						X
<i>Hisonotus francirochai</i>	X	X							
<i>Hisonotus marapoama</i>									X
<i>Hypostomus ancistroides</i>		X	X					X	
<i>Hypostomus iheringii</i>	X	X				X			
<i>Hypostomus regani</i>	X	X							
<i>Cetopsorhamdia iheringi</i>		X							
<i>Pimelodella avanhandavae</i>			X						
<i>Rhamdia quelen</i>	X								
<i>Cichlasoma paranaense</i>		X							
<i>Crenicichla jaguarensis</i>			X						
<i>Geophagus brasiliensis</i>				X					
<i>Satanoperca</i> sp.									X
<i>Phalloceros harpagos</i>	X	X			X			X	
<i>Poecilia reticulata</i>	X			X					

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